1898MNRAS..58..242B

ADDRESS

Delivered by the President, Sir Robert S. Ball, LL.D., F.R.S., on presenting the Gold Medal to Mr. W. F. Denning.

It is the duty of your President at this annual meeting of our Society to address you on a very important subject. I allude of course to the award of the Gold Medal which is annually conferred by the Royal Astronomical Society on some astronomer who has rendered signal service to our science. The discharge of that duty is perhaps the most responsible official act which devolves on the occupant of this chair, during his tenure of the distinguished position of President. I am to set forth the grounds upon which on the present occasion the medal has been awarded by your Council to our distinguished Fellow Mr. W. F. Denning.

At an early age Mr. Denning manifested that taste for the study of Natural Science, which by diligent cultivation has in due course led him to make those discoveries which we now propose to honour by the highest means in our power. In his boyhood, it was natural history in the study of field life to which, like many another illustrious man of science, he was specially attracted. But the 'stars which in Earth's firmament do shine,' though the stars of his first love, were not the stars by which he was destined to advance to fame. In 1865 Mr. Denning, being then a youth of 17, directed his attention to astronomy, and in the following year he became the possessor of a telescope of three inches aperture.

Stimulated by the views of the celestial glories offered him by this little instrument, Mr. Denning became, as does always the zealous observer, eager to increase the optical powers at his disposal. For a short time he pursued his observations with a 4¼-inch reflector, but this again only quickened his desire to have still greater aperture. His wishes in this direction were at last gratified, when in 1870 he purchased a 10¼-inch reflector by Browning. It is with this instrument that Mr. Denning's telescopic work, which we are presently to notice, has been chiefly done.

1898MNRAS..58..242B

The contributions of Mr. Denning to astronomy may be conveniently ranged under three heads :—

1. *Discovery of Comets.*
2. *Observation of Planetary Phenomena.*
3. *Researches on Luminous Meteors.*

It will be convenient for me to describe his work in these three different departments, taking them in the order just given.

The first and second departments must, however, be treated with comparative brevity, for in making their award your Council have laid special stress on Mr. Denning's Researches on Luminous Meteors.

1. *Comets.*

Each year usually brings the announcement of certain new comets. The discovery of such objects falls to those observers who patiently scan the heavens evening after evening, and morning after morning, with the particular object of detecting these shy visitors to our skies. Mr. Denning has been one of those who have engaged in this work, and his success has been noteworthy. The following list gives the designations of five comets which have been discovered by our medallist.

Comet	1881 V.	Period 8·68 years.
,,	1890 VI.	
,,	1891 I.	
,,	1892 II.	
,,	1894 I.	Period 7·3 years.

I think it will materially enhance our appreciation of Mr. Denning's perseverance and skill if we note the unique position which he occupies among astronomers in England, so far as the discovery of comets is concerned. Since the days of Caroline Herschel, the only comets, beside those just mentioned, which have been discovered in this country have been those which were detected by Hind and the remarkable object which was found by Mr. Holmes.

While searching the skies for comets Mr. Denning has not unfrequently discovered nebulæ which had escaped the attention of previous observers. No fewer than twenty-one nebulæ have thus been added by Mr. Denning to the lists of those already known. Most of these new objects lie in the vicinity of the North Pole.

2. *Planetary Observations.*

A striking characteristic of Mr. Denning's work is the methodical accuracy with which he has carried through whatever astronomical research he had in hand. Mr. Denning never spared

1898MNRAS..58..242B

himself any pains in the efforts necessary to give his work the inestimable charms of thoroughness and precision. This may well be illustrated by his work on *Jupiter*. It is well-known that this very difficult object not only demands instruments of much optical perfection, but also calls for the exercise of the highest qualities which constitute a consummate astronomical observer. Mr. Denning made admirable sketches of the planet, in which he represented a remarkable amount of detail with a skilful pencil. But he was not content with artistic work merely, however valuable such work may be; he patiently watched the revolutions of a large number of spots on *Jupiter*, and determined as accurately as possible their times of transit over the central meridian of the planet. By such observations he ascertained the periods of rotation of a large number of particularly well marked spots. Thus he illustrated the instructive fact that individual spots are animated by large proper motions on the surface of the planet. The famous red spot so well known to every astronomer has been in particular most diligently followed by Mr. Denning. He has demonstrated the remarkable circumstance that the period in which it returns to the central meridian of the planet varies from year to year. The results at which he has thus arrived are in close accordance with the observations of other accomplished astronomers.

3. *Researches on Luminous Meteors.*

The great work of Mr. Denning's scientific career, and that which has been mainly instrumental in deciding your Council to confer on him the distinction of the Gold Medal, has been devoted to the very important subject of luminous meteors. The labours of Mr. Denning have been so extensive (and they cover nearly every branch of the subject of meteorological astronomy), that it would be difficult—indeed, I may say it would be impossible—to render any adequate account of it within the limits of an address; I am therefore obliged to restrict myself to those more salient points which have specially influenced the decision of your Council.

The papers on luminous meteors communicated to the Royal Astronomical Society by Mr. Denning, and printed in the *Monthly Notices*, number altogether forty-two. In bulk they would, if collected together, constitute two-thirds of an ordinary annual volume in that form of the Society's publication. These papers are illustrated with graphic and instructive figures much more copiously than has usually been the custom in communications of this class.

A considerable number of these memoirs contain valuable lists of meteoric radiants, derived either exclusively from Mr. Denning's own work at Bristol or from his own observations in connection with the work of other astronomers in the same field.

1898MNRAS..58..242B

Mr. Denning's first published list of radiants appeared in 1876. It contains the determinations of twenty-seven radiant points derived from his own observations of nearly nine hundred meteor tracks which he had himself mapped at Bristol between 1871–6. In this early list the periods of the recurrence of the showers are occasionally indicated by single days or short periods, but usually the month of recurrence is alone given. The list contains careful determinations of the radiant points of the chief annual showers, such as *Quarantids* in 1873, the *Lyrids* in 1873 and 1874, the *Perseids* in 1871 and 1874, the *Orionids* in 1874, and the *Andromedids* in 1872. It is interesting to note that to all but four of the radiants in the list corresponding showers were found in Mr. Greg's first general star shower catalogue. This was published in comparison with Dr. Heis' and other well-known contemporary radiant-lists, in the British Association volume of *Reports* for the year 1874. The four radiants which Mr. Denning did not find corroborated in that general catalogue, are all, it ought to be observed, marked as doubtful ones in this early list.

The latest list of radiants which has been issued by Mr. Denning, and the longest paper that he has as yet communicated to the *Monthly Notices*, was published in 1890. This important work gives remarkable evidence of the diligence of our medallist. It contains a list of 918 radiant points, deduced from the observations of no fewer than 9177 meteors, mapped at Bristol between the years 1873 and 1889. This list, it should be remarked, includes repeated observations of the same radiants. This is the case, not only with regard to the chief showers, but also with regard to various minor showers whose yearly dates of recurrence cannot in the present state of our knowledge be assigned with any certainty.

Though many of these showers are but sparsely characterised by meteors—or, to use the more technical expression, are showers of great tenuity, they have not escaped the persistent scrutiny of Mr. Denning. In such cases the dates, are generally assigned to single days when the meteors have apparently maximum abundance. A column of supplementary dates, which seldom range over more than a week, has been added. It will thus be seen that this catalogue presents an extensive series, not so much of averaged results, as of exact and valuable individual determinations.

In other papers by Mr. Denning mean results have been given which may be regarded as summarising the present state of our knowledge with regard to many important showers. For the chief meteoric showers a list of this kind was published in 1888. In it will be found mean positions for 1880 derived from fifteen years of observations of the radiant points of the nine chief yearly showers. These contain the seven well-known periodic swarms of January, April, August, October, November (two showers), and December, adding to these the striking and

1898MNRAS..58..242B

very regularly visible displays of May 6 and July 28. A very useful list of 35 radiants is given by Mr. Denning in the *Admiralty Manual of Scientific Inquiry* (5th edition), 1886.

As an illustration of the perseverance and skill which has been shown by Mr. Denning in the determination of the positions of the radiants, I may mention the following circumstances with respect to the radiants of the *Lyrids*. In 1867 the April meteors were shown by Galle and Weiss to present a similarity of orbit to that of Comet 1, 1861. Weiss gave the cometary radiant as R.A. 270°·4, Decl. +33°·5, while Professor Herschel afterwards computed it as R.A. 270°·5 and Decl. +32°. The meteoric radiant was at R.A. 278°·2, Decl. +34°·5 (Galle and Karlinski), at R.A. 277°·5, Decl. +34°·5 (Greg and Herschel), at R.A. 277°, Decl. +38° (Heis), and at R.A. 267°, Decl. +35° (Serpieri). These positions gave a mean radiant a few degrees N.E. of the calculated radiant of the comet, and this discrepancy rendered the supposed identity of the meteors with the comet somewhat questionable. In 1873 and 1874 Mr. Denning watched the April meteors, but his observations were not very complete at that period, and he found the radiant at R.A. 274°, Decl. +37°. In 1878 and later years, having gained the experience necessary in critical meteoric work, he redetermined the radiant and found it practically identical with that computed from the cometary orbit. His positions were :—

	R.A.	Decl.	
1878 April 20–21	272°	+32°	10 meteors
1879 April 20	272°	+33°	8 „
1884 April 19	269°	+33°	17 „
1885 April 19–20	271°	+33°	24 „
1887 April 19–20	270°	+32°	11 „
1893 April 20–21	272½°	+33½°	15 „

The detailed accounts of Mr. Denning's observations of many special meteor showers constitute several of his most valuable papers. The first paper that he ever communicated to the Royal Astronomical Society related to the famous shower in 1872. I dare say many of those present will recollect, as I do myself, that beautiful display of the *Andromedids*. It may be noted, as a matter of interest on the present occasion, that this memorable night may also be said to coincide with the commencement of Mr. Denning's career in connection with our Society. But he has put it on record that he commenced to observe meteors some years earlier, on the occasion of the ever memorable display of the *Leonids* in 1866.

In this earlier paper Mr. Denning tells us, among other interesting matters, how he made his observations of the *Andromedids* in 1872. Watching with one companion between 6 and 6.30 that evening, they enumerated from seventy-five to eighty *Andromedids*, and only one unconformable meteor was noticed. Of

1898MNRAS..58..242B

the meteors they saw about ten or fifteen were at least of the first magnitude, and as the rest were bright enough to be seen in the hazy sky, they must have been of about the second magnitude. From the many tracks that were mapped down, as well as from some stationary meteors which were also noticed, the radiant point was found very well defined, and was located at R.A. 29°, Decl. +46°, about 4° north of γ *Andromedæ.*

With this early work of Mr. Denning's it is interesting to compare the observations that he made of the same shower when in 1885 it had completed two more revolutions. This he describes in the paper communicated that year to the *Monthly Notices.* If I give here an abstract of his observations, it is because I think it is no exaggeration to regard them as a model of the way in which the phenomena of luminous meteors should be watched for, and an instructive lesson as to the points to be specially recorded.

He commenced to watch for the great display of *Andromedids* in partly clouded sky on 1885 November 26. In a clear quarter of an hour, from 8.30 p.m. and later in a few periods, twenty-one and forty-two meteors respectively were counted by Mr. Denning and another observer. It is estimated that they were thus arriving at the rate of about 130 per hour. Of those seen nineteen and forty-one were *Andromedids,* and their radiant region, which was some degrees wide, appeared to have a centre about R.A. 26°, Decl. +44°. From midnight onwards the sky was overcast.

On the following night, 1885 November 27, a rich star shower was observed from twilight until 6.40 p.m., when clouds and rain came on. The number would probably have reached 5000 per hour had the sky been perfectly clear, for 222 were counted through the haze in the last and clearest five minutes, showing themselves in intermitting pulses or volleys of five to ten or more at a time. The radiation was decidedly diffuse, proceeding in a loosely disjointed way from an area fully 7° in diameter about a centre at R.A. 24°, Decl. +44° between γ and ξ *Andromedæ.* Several of the meteors seen on the 26th, and many on the 27th, were as bright as *Jupiter,* indeed some of those on the 27th were brighter than *Venus.* They seemed to be composed of loose materials crumbling away in their flight to spark dust ere they vanished.

A chart of forty-nine *Andromedids* and a list of twenty bright ones are given as observed on the evenings of November 26 and 27, showing the mean radiant-point at R.A. 25°, Decl. +44°.

Forty-five more *Andromedids,* half of them of rather smaller magnitudes, were noted in about four hours—on the evening of November 28, and a chart of their tracks showing a radiant-point at R.A. 22°, Decl. +43½° was also given.

Ten meteors of the same shower were seen on November 30 in 4½ hours, and these were sufficient to give a radiant at R.A. 21°, Decl. +42½°; but on December 1, 4, and 7, no further symptoms

1898MNRAS..58..242B

of the shower were traceable. In its whole duration of fully five days (it lasted very possibly one or two more days, for clouds prevailed at its commencement), the radiant-point was thus observed to recede about five degrees in right ascension.

The rather bright shower from *Andromeda* of forty per hour, which was seen on 1872 November 24, 7.30 to 12 p.m., at Newhaven, Conn., and more faintly on the following night, was certainly not continuous with the grand display of November 27 in the same year. The nights of November 25 and 26 were noted by Mr. Denning, at Bristol, as unsurpassed in November for paucity of meteors.

Another very interesting shower admirably studied by Mr. Denning was that from 1897 April 29 to May 6. Of all the shooting stars appearing through the year, there are none more striking for their long, bright, streak-leaving courses than those which from April 29 to May 6 may be seen after midnight proceeding from that radiant-point at the east horizon, first defined by Colonel Tupman in 1869–70 near α and η *Aquarii*. The orbit of Halley's comet approaches the earth's orbit near the position occupied by the Earth on May 4. The distance is about five and a half million miles on the inner side of the earth's track. The magnitude and brightness of that comet's tail projecting outwards from the Sun suggests the possibility of its connection with this shower. Fragments accompanying the comet would have an apparent radiant-point nearly at η *Aquarii*, but this is 12° E on the equator from the radiant found for the meteor shower by Colonel Tupman.

A trial was made by Mr. Denning to re-determine this star-shower's date and radiant-point exactly, by projecting 229 tracks in April and May from the Italian Meteor Association's Catalogue of about 7600 meteor paths observed in 1868–70. A resulting place at R.A. 335°, Decl. $-9°$ was obtained for the radiant-point. This is considerably southward and eastward from Colonel Tupman's position at R.A. 326°, Decl. $-2\frac{1}{2}°$, but yet does not agree very well with the computed radiant R.A. 337°, Decl. $\pm 0°$ on May 4, of a stream of meteor particles from Halley's comet.

The late hour of the radiant's rising, between 1^{h} and 2^{h} a.m., makes a good view of this splendid shower not easy to obtain.

Its centre had been noted by Mr. Corder from observations made in 1876–79, at R A. 334°, Decl. $-5°$. But the difficult task of carefully re-observing this shower's radiant-centre remained for Mr. Denning to accomplish, and he watched the sky on a succession of clear, moonless nights in April–May 1886, for 27 hours for this purpose, mapping in all 117 meteors in a time of unusual scarcity of shooting-stars, with a perseverance and success perhaps never surpassed in meteor-observations. From nine very accordant tracks of the beautifully long-pathed Aquarid meteors seen between April 30 and May 6, most abundantly on the latter date, and from three others which only

1898MNRAS..58..242B

deviated a few degrees from the position, the centre of the shower was found, with only slight diffuseness, to be at R.A. 337°, Decl. $-2\frac{1}{2}°$; all doubt of its agreement in place and date with the time and radiant-point of a shower connected closely in some way with the orbit of Halley's comet being thus clearly shown to be unfounded.

In the *Monthly Notices* for 1894 June, Mr. Denning sums up his extensive experience on the questions of the general directions of great fireballs, and of the brighter shooting stars as compared with those of ordinary shooting stars. He tells us that the striking objects commonly diverge from radiant-points at places in the western or anti-apical half of the sky, quite remote from the radiant-points of contemporaneous meteor showers. This noteworthy result is arrived at not only from most of Mr. Denning's own determinations of the real paths of such meteors, but from a numerous collection of published determinations of these paths which he has brought together for comparison with his own results.

This singularity of direction, for so it at first appeared, seems now to be a regular feature of the usual movements of fireballs. That a great fireball, leisurely streaming across the sky, should come from a westerly direction, is quite a normal circumstance; a movement in this direction is, however, rarely seen in the case of ordinary shooting stars.

Although a connection between a fireball and some weak contemporaneous shower may now and then be perhaps traced, yet many fireballs seem to be so isolated that Mr. Denning has been led to suspect that they "must either be merely single sporadic bodies, or else the survivors from some meteor group nearly exhausted by the waste of its material during many past ages."

In a weighty concluding paragraph touching the question of the similarity or the diversity of origin of meteorites, fireballs, and shooting stars, Mr. Denning quotes the late Professor H. A. Newton's striking conclusion from his study of observed paths of meteorites. It appears that, out of 116 stone falls investigated by the diligent American astronomer, 109 must have been overtaking the Earth, and only seven seem to have met the Earth. He infers from this that nearly all the stones in the Solar System move in direct orbits.

As an illustration of the thoroughness of the work of Mr. Denning in the interesting problem of the determination of the path of a fireball, we may consider the remarkable object which appeared at ten o'clock on the evening of 1894 January 25. This was a large detonating fireball which, in a generally clouded sky, is stated to have illuminated the north-western parts of England as brightly as the full Moon is able to do. It disappeared at the end of a long obliquely-descending course from N.W. to S.E. at a height of sixteen miles over a point three or four miles east from Tewkesbury. At Malvern and Worcester,

1898MNRAS..58..242B

on either side of the end of its track, as well as at other places, a violent explosion was heard which resembled a clap of thunder. The report reached Malvern after an interval of about three minutes, corresponding to a distance of 37 miles. Various other incidents of the explosion have been also collected from different sources.

Mr. Denning carefully sifted more than forty accounts of the occurrence collected from different English and Welsh localities. Those which were found to be available for the actual determination of the path of the fireball were the observations near Lancaster by Mr. Clapham, near Birmingham by Messrs. Packer and W. H. Wood, at Sunderland by Mr. Backhouse, and by Mr. Denning himself at Bristol. The visible extent of the meteor's real path thus obtained was found to be about 160 miles, which was traversed in about 9 seconds. Its course began 89 miles high over the Irish Sea, 24 miles N.N.E. from Amlwch, in Anglesey, and passing at heights of 45 and 22 miles nearly over Shrewsbury and Worcester to the above-named terminal point.

The direction of flight was from near ε *Cephei*, a place not known previously as a radiant-point of shooting stars so late in winter, although a centre near this was found on 1886 January 4–8 by Mr. Denning, and though in summer and in autumn months radiant-points in the same quarter are numerous. This point is, in fact, one of those enumerated in the list of 45 stationary radiant-points at the end of Mr. Denning's list of 918 radiant-points. It is noted as having been seen with very prolonged duration from June to December in the fine summer months of 1887. The parabolic meteor speed corresponding to this deduced radiant-point is 13¾ miles per second, while the observed velocity was 18 miles per second.

The most important contributions which Mr. Denning has made to the general problems connected with luminous meteors are undoubtedly connected with the long duration of meteoric radiants. The fact of long persistency of radiant-points, and of close assemblages about the points, of groups or compact families of simultaneous or successive meteor streams is as old as Heis' first essays in meteor showers. It is, however, to Mr. Denning's inquiries that we are indebted for our knowledge of this subject. In his important paper of 1884 December, Mr. Denning writes: "The fact of stationary radiants exhibiting visible activity during several months is a phenomenon so unaccountable and so utterly opposed to the approved theories as to the orbits of shooting stars that it must receive a most crucial examination before it can be accepted."

The long-continued labours of Mr. Denning on this important subject have demonstrated the existence of these enduring radiants. The theoretical difficulties connected with the subject may be still not altogether removed, but we can hardly refuse assent to Mr. Denning's words when he says: "It must be conceived that a well-attested fact of observation, however hard to

1898MNRAS..58..242B

reconcile with known theories, ought on no account to be disregarded on account of its nonconformity."

It is, of course, known that the *Perseids* of the August meteor-shower are found, not only on the special nights with which the swarm is chiefly associated; they are also displayed on many preceding and following nights. Mr. Denning has traced meteors of this group for the twenty-six nights from July 25 to August 19, and their radiant advanced in that interval over a distance of forty degrees. In one of those admirable diagrams by which the interest of Mr. Denning's papers is so greatly increased, he gives a curve of the ordinary number of *Perseids*, rising from one on July 25 to a maximum of fifty-seven on August 10, and then declining to one on August 19. In his paper of 1890 Mr. Denning shows that the range of the *Perseids* is even wider still. I cite this case of the *Perseids*, because the gradual shift of the radiants, as days and weeks pass by, is of course no more than should be expected from the change of the place of the Earth in its orbit. The extraordinary fact is that in the case of certain other showers, which are visible for weeks or months, the radiant undergoes no appreciable change in position.

The six showers that Mr. Denning specially selects for discussion in his memorable paper of 1884, are as follows; we direct special attention to these results, because they may be regarded as the authoritative announcement of the important discovery under consideration.

	Radiant.		Apparent Duration.	Shower.	Positions Averaged.
	R.A.	Decl.			
I.	30°·0	+36°·0	July 16–Nov. 14	β Triangulids	23
II.	46·0	+45·6	July 6–Nov. 30	α–β Perseids	31
III.	61·0	+47·7	July 25–Nov. 27	μ Perseids	21
IV.	61·8	+36·8	Aug. 2–Dec. 31	ε Perseids	26
V.	76·2	+32·6	July 23–Dec. 27	ι Aurigids	21
VI.	80·2	+22·9	Aug. 24–Jan. 15	ζ Taurids	25

Taking the second of these showers as an example, we have fifteen determinations of the radiant II., by Mr. Denning himself, extending from July 6 to November 14. The mean of that concordant series of determinations places the radiant at R.A. 46°·1 and Decl. +45°·0.

Then follow sixteen determinations of the radiant by other skilled observers of meteors, Schmidt, Tupman, Schiaparelli and Zezioli, Maggi, Heis, Corder, Sawyer, Greg, and Herschel. Here again we have another series of results extending from August 3 to November 30, placing the mean radiant at R.A. 45°·8, Decl. +46°·2. It is impossible to resist the logic of these facts; whatever may be their explanation, the existence of the enduring radiants must be admitted.

1898MNRAS..58..242B

Such a paper as that which I am now referring to must be regarded as a classic which everyone who desires to devote himself to the fascinating subject of meteors would do well to study. It is full of interesting facts and suggestion. We learn that in the catalogues published up to this date there are no fewer than 2100 radiants resulting from the projected paths of upwards of 62,000 meteors; many of these are known duplicate observations of identical streams, and Mr. Denning adds that he does not believe the total number of well defined streams would exceed 350.

Mr. Denning has given in the introduction to his great catalogue of 1890 a very interesting general statement of his methods of work.

"My plan of working may be briefly described as follows:—All the observations were made in the open air, and from the garden adjoining the house. Attention was almost invariably given to the eastern sky. In mild weather I sat in a chair with the back inclined at a suitable angle; but on cold, frosty nights I find it expedient to maintain a standing posture, and sometimes to pace to and fro, always, however, keeping the eye directed towards the firmament in quest of meteors."

"I find it essential to rely on the latter instrument (a perfectly straight wand) as a help and corrective to the eye in ascribing the lines of flight. When a meteor was seen the wand was immediately projected upon its track and the position quickly noted and reproduced on an 18-inch celestial globe. The time, magnitude, appearance, beginning-point and probable radiant were then written down, and other details left to be filled in on the following day, when all the paths were carefully compared and their provisional radiants derived."

Mr. Denning points out that in open country places the mean horary number of meteors is 11·4. The average lengths of the paths of all the meteors he has observed is 10°, and the maximum number of meteors is attained between 2 and 3 a.m., when the rate is nearly double that in the early hour of the evening.

On the important subject of stationary radiants additional information has been acquired during the five years following the important statement of 1884. It has been tested by about 5000 observations made since that time, and the new materials certainly seem to corroborate the conclusion already arrived at. Mr. Denning here again refers to the remarkably long enduring shower between α and β *Persei.* He has obtained several fresh determinations of it, and he gives it as one of the best instances of an apparently stationary radiant. The following is the remarkable table referred to:—

1898MNRAS..58..242B

Long enduring shower between α and β Persei.

		R.A.	Decl.			R.A.	Decl.
		°	°			°	°
1877	July 20	47	+45	1885	Sept. 15	48	+43
1884	July 23–25	48	+43	1877	Sept. 15–16	47	+45
1886	Aug. 2–10	48	+43	1886	Sept. 22–30	48	+44
1888	Aug. 5–14	48	+44	1887	Oct. 17–24	47	+44
1877	Aug. 3–16	46	+45	1879	Oct. 20	45	+46
1884	Aug. 19–21	46	+44	1879	Nov. 12–14	48	+43
1879	Aug. 21–23	46	+47	1877–86	Nov. 27–Dec. 8	48	+42
1887	Aug. 30	46	+43	1886–8	Dec. 28–Jan. 11	47	+44
1887	Sept. 12–24	47	+43	1876–87	Feb. 23–Mar. 12	47	+45

Mr. Denning has recently published in the *Observatory* an instructive and opportune series of papers on the expected great showers of *Leonids* in the next few years. This subject is here discussed with that wealth of knowledge and experience which characterises all Mr. Denning's contributions. He commences these papers with the words :

"It may safely be said that in the month of November during the next few years, all astronomers and a large majority of the general public will become meteoric observers, for the phenomena presented will be of an exceptional kind, and of a character to interest everyone."

We all echo these remarks. I think I am justified in adding that much of the recently-awakened interest in the subject has been due to the worthy example Mr. Denning has himself given us. Who among us would not be proud to imitate his single-hearted and enthusiastic devotion to the discovery of truth in this beautiful department of astronomy ?

It is a matter of great regret to everyone here assembled that our medallist, whom we so greatly wish to honour, is not now present in person to accept our award. We regret this all the more when we learn that ill health is the cause of his absence. We unite in expressing a hearty wish for his speedy recovery. We assure him not only of our appreciation of his admirable work, but of the high esteem which we personally entertain for him. On your behalf, therefore, I now hand the Gold Medal of the Royal Astronomical Society to our Secretary, to be by him transmitted to Mr. W. F. Denning in recognition of the valuable services to our science which he has rendered, especially in the department of meteoric astronomy.